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CLAIMS

1. Thermal insulation structure comprising at least one flexible layer based on compressed expanded graphite particles characterised in that the density of the said flexible layer, called dense compressed expanded graphite layer, is equal to at least 0.4 g/cm^3 (400 kg/m^3) and in that the said thermal insulation structure also comprises another layer called sub-dense compressed expanded graphite layer, based on compressed graphite particles with a lower density, typically less than 0.4 g/cm^3 (400 kg/m^3).
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2. Thermal insulation structure according to claim 1 in which the said dense compressed expanded graphite layer has a density of between 0.5 and 1.6 g/cm^3 (500 and 1600 kg/m^3) and the said sub-dense compressed expanded graphite layer has a density of between 0.05 and 0.3 g/cm^3 (50 and 300 kg/m^3).
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3. Thermal insulation structure according to claim 1 or 2 in which the said dense and sub-dense layers made of compressed expanded graphite are adjacent and are bonded to each other by carbonation of a carbonisable binding agent, typically phenolic resin, furfuryl resin or pitch.
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4. Thermal insulation structure according to claim 3 in which the adjacent dense and sub-dense layers made of compressed expanded graphite are intimately bonded together over their entire contact surface.
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5. Thermal insulation structure according to any one of claims 1 to 4 obtained by stacking the said adjacent dense and sub-dense layers, with one alternation of dense and sub-dense layers made of compressed expanded graphite.
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6. Thermal insulation structure according to any one of claims 1 to 5 in which the said sub-dense layer or layers made of compressed expanded graphite have a total thickness of less than 40 mm, and typically between 5 and 20 mm.

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7. Thermal insulation structure according to any one of claims 1 to 6 in which the said dense layer or layers made of compressed expanded graphite have a total thickness of less than 2 mm, and typically of between 0.5 and 1.5 mm.

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8. Thermal insulation element designed to be fitted on furnaces operating in a non-oxidising atmosphere and at temperatures of more than 800°C, characterised in that it comprises a thermal insulation structure according to any one of claims 1 to 7.

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9. Thermal insulation element according to claim 8, characterised in that it forms part of the wall of the chamber of a furnace operating at temperatures of more than 800°C and in a non-oxidising atmosphere.

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10. Thermal insulation element according to claim 9, characterised in that it is in the form of a brick, such that the assembly of several of these bricks forms the surface of the combustion chamber of the said furnace.

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11. Thermal insulation element according to claim 9, characterised in that it is in the form of a cylindrical wall in one or more parts making up the combustion chamber of the said furnace.

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12. Thermal insulation element according to any one of claims 8 to 11, characterised in that its apparent surface is covered with a dense compressed expanded graphite layer with a density of more than

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0.4 g/cm³ (400 kg/m³) typically between 0.5 and 1.6 g/cm³ (500 and 1600 kg/m³).

13. Method for manufacturing a thermal insulation structure, characterised
5 in that it comprises the following steps:
- a) making at least one "thick" sub-dense strip with a thickness of less than 40 mm, typically between 5 and 20 mm, by limiting the density obtained by compression of graphite particles to small values of the order of 0.1 g/cm³ (100 kg/m³) and typically within the range of 0.05 g/cm³ (50 kg/m³) to 0.30 g/cm³ (300 kg/m³);
 - b) making a "thin" dense strip with a thickness of less than 2 mm, typically between 0.15 and 1.5 mm, with a density within the range of 0.5 to 1.6 g/cm³ (500 to 1600 kg/m³);
 - c) joining said two strips, typically by co-lamination, so as to form multilayer structures that comprise an alternation of thick sub-dense / thin dense layers, with at least two elements, said assembling being made as follows:
 - c1) the said sub-dense thick strip is coated with a liquid solution rich in carbon, typically a phenolic resin, a furfuryl resin or pitch;
 - c2) almost all solvents in the solution, if any, are then eliminated by slow drying;
 - c3) the said dense thin strip is then added to the coated surface;
 - c4) heat treatment of thus joined strips under a non-oxidising atmosphere at a temperature of not less than 800°C.
14. Manufacturing method according to claim 13, modified so that two dense thin strips are made in step b) and in that a sub-dense thick strip is placed, typically by co-lamination, between the said two thin strips in step c).

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15. Manufacturing method according to claim 13, modified so that two sub-dense thick strips are made in step b) and in that a dense thin strip is placed, typically with co-lamination, between the said two sub-dense thick strips in step c).

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16. Method for manufacturing a brick of a thermal insulation element, characterised in that a thermal insulation structure is made according to the method in claim 14, and in that the structures thus made are then cut to the required dimensions.

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17. Method for manufacturing a thermal insulation element, characterised in that it comprises the following steps:

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a) a thermal insulation structure is made according to the method in claim 13, the said structure being sufficiently flexible so that it can be wound spirally on a cylindrical support afterwards;

20 b) before winding, the sub-dense thick layer of the structure is coated with a liquid solution rich in carbon, typically a phenolic resin, a furfuryl resin or pitch, and then almost all solvents in the solution, if any, are eliminated by slow drying;

c) the structure thus obtained is wound spirally on several layers so as to obtain a cylindrical jacket with the required thickness;

d) the cylindrical face of the said cylindrical jacket that is occupied by the sub-dense layer is covered with a flexible strip made of dense compressed expanded graphite;

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e) the jacket is heat treated under a non-oxidising atmosphere at a temperature equal to at least the temperatures that the thermal insulation will need to resist during use, typically 800°C, and preferably 1000°C or more.

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18. Method for manufacturing a thermal insulation element designed to be fitted on furnaces operating in a non-oxidising atmosphere and at temperatures of more than 800°C, characterised in that it comprises the following steps:

- 5 a) a sub-dense compressed expanded graphite layer is made with a density of less than 0.4 g/cm³ and with a thickness of less than 25 mm,
- b) the said strip is curved so that it is in the form of a portion of a cylinder,
- c) after bending, the strip is glued,
- d) a reinforcing layer is applied made of a dense compressed expanded graphite, with a density of more than 0.4 g/cm³, on one or two of the faces of the curved strip,
- 10 e) the assembly is then heat treated while being held in shape by a graphite conforming jig surrounding the product.